

N91-26018

The Effect of Electron Collisions on Rotational Excitation of Cometary Water

Xingfa Xie* and Michael J. Mumma[†]
Laboratory for Extraterrestrial Physics

Code 693

NASA Goddard Space Flight Center
Greenbelt, MD 20771

March 28, 1991

The $e\text{-H}_2\text{O}$ collisional rate for exciting rotational transitions in cometary water is evaluated for conditions found in Comet Halley. The $e\text{-H}_2\text{O}$ collisional rate exceeds that for excitation by neutral-neutral collisions at distances exceeding 3000 km from the cometary nucleus, in the case of the $0_{00} \rightarrow 1_{11}$ transition. The estimates are based on theoretical and experimental studies of $e\text{-H}_2\text{O}$ collisions, on ion and electron parameters acquired in-situ by instruments on the Giotto and Vega spacecraft, and on results obtained from models of the cometary ionosphere. The contribution of electron collisions may explain the need for large water-water cross-sections in models which neglect the effect of electrons. The importance of electron collisions is enhanced for populations of water molecules in regions where their rotational lines are optically thick.

*Astronomy Department, University of Pennsylvania, Philadelphia, PA 19104.

[†]Chief Scientist, Planetary and Astrophysical Sciences.

The Ephemeris Development Effort for Asteroid 951 Gaspra

D.K. Yeomans (JPL/Caltech)

En route to its encounter with Jupiter, the Galileo spacecraft will fly closely past asteroid 951 Gaspra on October 29, 1991. While the pre-encounter spacecraft images of the asteroid on the star background will be used to dramatically improve the knowledge of its position in the spacecraft - asteroid target plane, the component of its position uncertainty in the spacecraft - asteroid direction will remain relatively unchanged. The spacecraft's close approach time will remain relatively large and can only be improved using ground-based astrometric measurements of the asteroid. Thus, the extent to which the onboard camera must mosaic to successfully image Gaspra will depend upon the accuracy with which its ephemeris can be improved using ground-based astrometric observations. These data now extend back to 1913.

Additional efforts are being made to improve the accuracy of recent astrometric observations including those that will be made throughout the spring and summer of 1991 and end just a few weeks prior to the spacecraft encounter itself. Arnold Klemola (Lick Observatory) and William Owen (JPL) have developed special Lick Observatory reference star catalogs for Gaspra whereby the positions of stars within one degree on either side of its apparent celestial path have been re-determined using either the new PPM catalog (northern hemisphere) or the Perth 70 catalog (southern hemisphere). Within 2' of the asteroid's path, all stars (9-16 mag.) were included in the catalogs while out to 1° on either side of the paths, an approximate density of 27 stars per square degree has been achieved. These special reference star catalogs have been distributed to a group of experienced observers for reducing their astrometric data. As a result of these special star catalog efforts, and the dedication of a small group of astrometric observers, the Gaspra position uncertainty at the time of the Galileo encounter is expected to be less than 200 km.

Using Radar Data to Improve the Orbits of Asteroids and Comets

D.K. Yeomans (JPL/Caltech)

Since the time of the first radar observations of asteroid 1566 Icarus in June 1968, there have been successful radar experiments involving over 60 different mainbelt and near-Earth asteroids (Ostro 1989, *Asteroids II*; Ostro et al. 1991, AJ, submitted). Although the focus of these radar experiments has been to infer the asteroids' physical characteristics from the echoes and properties of the returned signals, corrections to the predicted Doppler and/or time delay ephemerides are also obtained. The measured differences between the transmitted and received frequencies (Doppler shifts) and the round trip time delays can provide extremely powerful data types for the orbit determination of asteroids and comets (Yeomans et al. 1987, AJ, 94,189).

Radar observation residuals can be typically 1 Hz in Doppler and about a microsecond in round-trip delay time. At the Arecibo transmitter frequency (2380 MHz), these errors correspond to range and velocity errors of 150 m and 6.5 cm/sec. For the Goldstone frequency (8495 MHz), the corresponding velocity error is less than 2 cm/s. The power of the radar data becomes evident when one realizes that radar measurement errors are orders of magnitude smaller than the position and velocity uncertainties inherent in orbits based only upon optical data over short time intervals.

Astrometric radar data effectively measures the object's distance and velocity along the observer's line-of-sight and hence these data are complementary to optical, plane-of-sky measurements. Radar data taken during an object's close approach to the Earth are most powerful, and the orbit refinement most dramatic, if the object has only a short optical astrometric history. A case in point is the recovery of minor planet 1989 PB by M. Hartley, S.M. Hughes and R. McNaught at the Anglo-Australian Observatory on May 3, 1990. Using an ephemeris based upon the 65 available optical position measurements over the interval from 1989 August 1 - 24, the predicted and observed positions of the object on May 3, 1990 differed by 37" in right ascension and 23" in declination. Had an orbit been available that included the 6 Doppler and 6 delay measurements, in addition to the optical observations, the predicted and observed positions differences would have been reduced to 1.4" and 0.8."

For the 30 asteroids and 2 periodic comets for which radar astrometric data was given by Ostro et al. (1991, AJ, submitted), Yeomans et al. (1991, AJ, submitted) computed orbits using both the radar and the existing optical measurements. Ten of these objects were considered by Weissman et al. (1989, *Asteroids II*, 880) to be extinct comets and Yeomans (1991, AJ, in press) found that for at least one of them, 1566 Icarus, the inclusion of a cometlike, outgassing acceleration model was required to successfully fit the observations.

With the relatively recent realization that a large population of near-Earth asteroids are on Earth approaching orbits, there is a critical need to accurately monitor their future motions. For the majority of these objects that lack a long history of optical astrometric data, accurate extrapolations of their motions will require the use of radar data in future orbital solutions.

230 ATHAMANTIS: ROTATION PERIOD AMBIGUITY

Young, James W. and Harris, Alan W.

Jet Propulsion Laboratory - California Institute of Technology

Partial photometric lightcurves of the asteroid 230 Athamantis over a 28-year span of time are presented. An original estimated 8 hour rotational rate by the Chinese (Purple Mountain) has been found incorrect, but the remaining two period ambiguities of 12 hours or 24 hours has yet to be determined.

ON DYNAMICAL STRUCTURE OF THE TROJAN GROUP OF ASTEROIDS;
R.V.Zagretdinov and I.P.Williams, Queen Mary and Westfield College, London, U.K.
M.Yoshikawa, Tokyo Astronomical Observatory, Japan

Using a semi-analytical model, the motions of Trojan asteroids in the three-dimensional elliptic restricted three body problem is considered. Regions where changes of semimajor axes and critical argument (mean longitude of Jupiter minus that of asteroids) occur for various sets of proper eccentricity, proper inclination and longitude of perihelion of asteroids minus that of Jupiter are plotted.

Using an analytical theory, amplitudes and periods of libration, for 70 Trojans has been calculated. Comparison with the results of Shoemaker et.al.(Asteroids II,1989) and of Bien and Schubart (Astron. Astroph.,175,292,1987) have been made, and in most cases good agreement was found. In addition, the possible presence of second order resonance among the real Trojan asteroids had been investigated.

A COMPARISON BETWEEN FAMILIES OBTAINED FROM DIFFERENT PROPER ELEMENTS

V. Zappala⁽¹⁾, A. Cellino⁽¹⁾ and P. Farinella⁽²⁾

- (1) Osservatorio Astronomico di Torino
strada Osservatorio 20
I-10025 Pino Torinese (TO) - ITALY
- (2) Dipartimento di Matematica
Universita' di Pisa
via Buonarroti 2
I-56127 Pisa - ITALY

Using the hierarchical method of family identification developed by Zappala' et al. (Astron.J., 100, 2030, 1990) we compare the results coming from the data set of proper elements computed by Williams (about 2100 numbered + about 1200 PLS II asteroids) and by Milani and Knezevic (5.7 version, about 4200 asteroids). Apart from some expected discrepancies due to the different datasets and/or low accuracy of proper elements computed in peculiar dynamical zones, a good agreement was found in several cases. It follows that these high reliability families represent a sample which can be considered independent on the methods used for their proper elements computation. Therefore, they should be considered as the best candidates for detailed physical studies.

Introduction: The Science Instruments of HST

Benjamin H. Zellner, Computer Sciences Corporation, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore MD 20771

NO ABSTRACT AVAILABLE

Some Interesting Targets for Future Work

Benjamin H. Zellner, Computer Sciences Corporation, Space Telescope Science Institute, 3700 San Martin Drive, Baltimore MD 20771

NO ABSTRACT AVAILABLE

A CANDIDATE FOR THE PARENT BODY OF THE TAURID COMPLEX AND ITS SEARCH EPHEMERIS; K. Ziolkowski, Space Research Centre, Bartyccka 18, 00-716 Warszawa, Poland

Untypical asteroid 5025 P-L, which has its perihelion close to the orbit of Mercury and its aphelion between the orbits of Jupiter and Saturn, seems to be a good candidate for the parent body of the Taurid complex of small interplanetary objects. Evidences that this asteroid is a major source of meteoroids as well as an analysis of the orbits of asteroidal and cometary members of the Taurid complex presented in the paper, lead to conclusion that 5025 P-L might be regarded as a remnant of a giant comet which was a progenitor of the overall complex according to the hypothesis of Clube and Napier. Unfortunately, the orbit of 5025 P-L is very poorly determined because the computations were based upon only three positional observations over an arc of only four days in October 1960. Any further research on the problem of origin and evolution of the Taurid complex needs better determined orbit of this key asteroid. Therefore its new positions are necessary. In order to enable the search of eventual trails of 5025 P-L on the plates which can be found in archives, its ephemeris for the opposition in 1960, when the asteroid passed about 0.5 AU from the Earth, is presented.

CoMA - a high resolution time-of-flight secondary ion mass spectrometer (TOF-SIMS) for in situ analysis of cometary matter

H. Zscheeg, J. Kissel, Gh. Natour

Introduction

To shed some light on the origin and history of comets and thus on the formation of the solar system, a detailed in situ analysis of the elemental, isotopic and molecular composition of solid and gaseous cometary - and therefore pristine - matter is highly desirable. The cometary matter analyzer CoMA being developed for the NASA 9 year cometary rendezvous and asteroid flyby mission (CRAF), will meet this desire by examining dust grains and gas originating from a comet, probably Tempel 2. CoMA is a contribution of the FRG.

The goals

CoMA will perform the analysis of cometary samples with an unprecedented mass resolution for a space instrument. Thus it will be able to separate the isotopes of a number of light elements (H, Li, C, Mg) and also to minimize the effects of molecular interferences. This translates to a resolution > 3000 at 13 da and > 13000 at 350 da. CoMA will comprise a mass range up to 3000 da.

To achieve this, the instrument consists of three basic units: the dust collector subsystem, the primary ion gun and the time-of-flight mass spectrometer.

The dust collector subsystem accommodates about 120 target devices of different structures. It will mechanically move the targets from the collect- to the store-, sputter- and analyze-positions and also add to the electric scan capability of the ion source a mechanical one.

The high brightness liquid metal primary ion gun /2/ produces 10 keV 1 ns pulses of isotopically pure ^{115}In ions and forwards them into a 20 μm spot on the sample. A DC mode is used for erosion purposes.

The time-of-flight mass spectrometer is able to compensate for second order flight time variations originating in the energy spread of the secondary ions by using a two staged ion reflector /1/. Folding of the ion flight path by implementing an additional ion mirror reduces geometric dimensions.

Status of CoMA

The feasibility of the basic design was verified by a first model, using components of standard mechanical precision and a 3 ns pulse UV-laser for secondary ion production.

Measurements with a second model basically resembling the flight unit were successful. A similar model underwent first vibration tests.

The primary ion gun in its present state can deliver 2.8 ns ion pulses generated by a combination of scanning the DC-beam across an aperture and subsequently bunching the emerging pulses.

Also under way is the development of an efficient secondary ion detector, a chevron type channelplate assembly with integrated amplifier.

Time measurement electronics evolve on a digital and an analog track. The digital version is centered around a delay line and the analog one around ramp generators. Presently both versions are capable of flight time measurements of 1ns accuracy.

/1/ B. A. Mamyryin, V. I. Karataev, D. V. Shmikk, and V.A. Zagulin: "The mass-reflectron, a new nonmagnetic time-of-flight mass spectrometer with high resolution" Sov.Phys.-JETP, Vol.37, No. 1, July 1973

/2/ J. Kissel, H. Zscheeg and F. G. Ruedenauer: "Pulsed Operation of a Liquid Metal Ion Source" Appl. Phys. A 47, 167-169, (1988)

Author Index

A'Hearn M. F.	1, 34, 61, 64, 111, 160, 183, 232	Bourgeois G.	24
Ahrens T. J.	203	Bowell E.	34, 93, 96, 154, 198
Aikman C.	54	Bowers C. W.	60
Albrecht R.	2	Brandt J. C.	29, 167, 232
Alfimova E. V.	2	Brisbin J.	54
Allamandola L. J.	23	Britt D. T.	30
Allton J. H.	3	Brooke T. Y.	233
Andreev V. V.	4	Brown M.	111
Aoki T.	182	Brown M. E.	31
Aoki T. E.	230	Budzien S. A.	61, 180
Arpigny C.	5, 232	Buie M. W.	32
Asher D.	207	Buratti B. J.	33
Atzei A.	6	Burke L.	219
		Burns J. A.	84
		Bus S. J.	34, 185
Babadzhanov P. B.	7, 8		
Baggaley W. J.	9	Campins H.	35, 226
Baguhl M.	10, 76	Capaccioni F.	57
Bailey M. E.	83	Capria M. T.	129
Baille P.	11	Cash W.	209
Bao Y.	101	Cellino A.	19, 35, 251
Baratta G. A.	12	Celnik W. E.	188
Barbieri C.	132	Cepkecha Z.	36
Barker E. S.	211	Chamberlin A.	150
Bar-Nun A.	13	Chapman C. R.	37, 38
Barucci A.	14, 15	Chauvineau B.	39
Barucci M. A.	129	Chen F. Z.	243
Baum W. A.	232	Chernova G. P.	86, 112, 113
Bec-Borsenberger A.	16	Chernykh N. S.	39
Belkovich O. I.	4, 16	Chin G.	233
Bell J. F.	17, 74	Churyumov K. I.	40
Belskaya I. N.	18	Clairemidi J.	41, 181
Belton M. J. S.	18, 19, 234	Cochran A. L.	42, 211
Bendjoya P.	19	Cochran W. D.	42
Bendjoya Ph.	20	Colom P.	24, 43
Benedix G. K.	149	Combi M.	66
Benest D.	20	Combi M. R.	44
Bénit J.	179	Cook T. A.	209
Benson C.	35	Coradini A.	57
Betlem H.	104	Coradini M.	15
Binzel R. P.	21, 22	Corbach E.	83
Birch P. V.	1, 160, 186	Cosmovici C.	130
Birkle K.	25	Crovisier J.	24, 43, 45, 108
Blair W. P.	60	Cruikshank D. P.	220
Blake D. F.	23	Cunningham C.	45
Bockelée-Morvan D.	24, 43	Cunningham C. J.	46
Boehnhardt H.	25		
Boice D. C.	26	Dahlgren M.	47, 67, 129
Bois E.	27	Davidson A. F.	60
Bonev T.	28		

Davis D. R.	38	Froeschlé Cl.	19, 20, 27, 58, 70
Debi-Prasad C.	48, 169	Fulchignoni M.	14, 15, 129
de Groot M.	103	Gada A.	54
de Lafontaine J.	89	Gaffey M. J.	71, 72
de Lignie M.	104	Geballe T. R.	233
Delva M.	48	Gehrels T.	191
Dermott S. F.	49, 55	Gérard E.	24
De Sanctis C.	15	Gerasimov I. A.	2, 205
Despois D.	43	Gerth C.	102
Di Martino M.	14, 15, 50, 73, 152	Getman V. S.	72, 73
DiSanti M.	51, 92, 155	Geyer E. H.	28, 48, 169
DiSanti M. A.	66	Giese B.	128
Dichko I. A.	79	Goldader J. D.	220
Dinev C.	51	Gomes R. S.	49
Dixon W. V.	60	Gonano-Beurer M.	50, 73, 152
Dones L.	52	Goncz R.	20, 58
Donn B.	5	Gooding J. L.	3
Dossin F.	5	Gosine J.	101
Doyle L. R.	238	Granahan J. C.	74
Drobyshevski E. M.	53	Green D. W. E.	108
Dunham D. W.	54	Green J. C.	209
Durda D.	49	Greenberg J. M.	103, 124
Durda D. D.	55	Greenberg R.	159
Durrance S. T.	60	Grensemann M. G.	75
		Grün E.	10, 76, 82, 120
Eich G.	179	Grundy W. M.	77
Elst E. W.	55	Gulak Yu. K.	78, 79
Engel L.	173	Gull T. R.	60
Engle S.	56	Gustafson B.	49
Espinasse S.	57	Gustafson B. Å. S.	80, 81, 82, 83
Evlanov E. N.	69		
		Hadamcik A.	133
Farinella P.	35, 39, 58, 251	Hahn G.	47, 83
Fechtig H.	76	Halliday I.	72
Federico C.	57	Hamabe M.	182
Feldman P. A.	72	Hamburger D.	11
Feldman P. D.	59, 60, 61, 64, 180, 232	Hamilton D. P.	84
Ferguson H. C.	60	Hanner M. S.	76
Ferrin I.	62	Harris A. W.	85, 86, 249
Ferro A. J.	63	Hartman W. K.	220
Festou M. C.	59, 61, 63, 64, 132, 176	Hartung J. B.	87
Filimonova T. K.	16	Hasegawa H.	88, 184
Filonenko V. S.	40	Hauser M. G.	139
Fink U.	44, 65, 66, 77, 219	Hawkes R. L.	178
Fitzsimmons A.	67	Hechler M.	89
Fletcher M.	54	Helin E. F.	90
Flynn G. J.	68	Hendricks C.	102
Fomenkova M. N.	69	Henry R. C.	60
Freudenreich H. T.	139	Heyd R.	91
Freund F.	23	Heyd R. S.	172, 173
Froeschlé C.	176	Hicks M.	65
Froeschlé Ch.	58, 70	Hiromoto N.	230

Hirose T.	54	Koczet P.	188
Hoban S.	51, 92, 116, 155	Kohl H.	10, 120
Hoffman H.	152	Kölzer G.	121
Hoffmann M.	92	Komitov B.	99
Holt H. E.	93	Kömle N. I.	122
Hopp U.	25	Konno I.	26, 123, 125, 182
Howell E. S.	33	Kouchi A.	124
Hu Z.-W.	94, 227	Kozuka Y.	123, 125, 182
Hudgins D.	23	Kresák L.	126, 127
Huebner W. F.	26	Kresáková M.	126, 127
		Kriss G. A.	60
Ibadov S.	95	Kruk J.	60
Innanen K. A.	96	Kuert E.	128
Ip W.-H.	97	Kurihara H.	212
Ipatov S. I.	98	Kwiatkowski T.	128, 151
Isobe S.	182		
Ivanova V.	99	Lacy J.	51
Iwase M.	184	Lagerkvist C.-I.	47, 67, 129
		Lamberg L.	109
Jackson A. A.	100	Lamy P.	130
Jackson W. M.	101, 102	Larson S. M.	131
Jayaraman S.	49	Lazzarin M.	132
Jenniskens P.	103, 104	Lebofsky L. A.	30
Jiang H.-S.	94	Lein D. J.	136
Jockers K.	28, 48, 169	Levasseur-Regourd A. C.	133
Jones J.	104, 105, 106	Levison H. F.	134, 135
Jones L. V.	86	Li R.-L.	94
Jones W.	104, 106, 107	Li Z.-L.	94
Jorda L.	108	Lichtenegger H.	48
Joyce R.	92	Light R. M.	232
Judge D. L.	243	Lindblad B. A.	76, 137
Julian W. H.	19	Lindgren M.	138, 217
		Linkert D.	76
Kaasalainen M.	109	Linkert G.	76
Kaiser R.	110	Lisse C. M.	139
Kamél L.	176	Long K. S.	60
Kato M.	216	Lumme K.	109
Kawabata K.	184	Lundstrom M.	47
Keay C.	111	Lunine J. I.	56
Keller H. U.	128	Lupishko D. F.	86, 113, 140
Kelsall T.	139	Luu C.	101
Kim S. J.	111	Luu J. X.	141
Kimble R. A.	60		
Kingsley S. P.	107	Mack P.	91
Kiselev N. N.	86, 112, 113	Magnusson P.	67, 129, 142
Kissel J.	76, 254	Maley P.	54
Klačka J.	114, 115	Manara A.	143
Klavetter J. J.	116	Marcialis R. L.	33
Kleine M.	116, 174, 234	Mardon A. A.	144
Knežević Z.	117, 151	Mardon E. G.	144
Kochan H.	118, 121, 168	Markiewicz W. F.	118
Kochetova O. H.	119	Marsden B. G.	145

Matese J. J.	146, 238	Osborn W.	54
Mathews J. D.	73	Osip D. J.	1, 160, 185, 186
Matson D. L.	225		
Matthews C. N.	147	Parmar R.	51
McCrosky R. E.	36	Paubert G.	43
McDonnell J. A.	76	Pauwels Th.	161, 162
McDonnell J. A. M.	148	Peale S. J.	163
McFadden L. A.	149, 150	Peterson B. A.	116
McKinnon W. B.	197	Petit J. M.	70
McNaught R.	207	Pittich E. M.	164
Meisser W.	188	Porubčan V.	137, 165
Michalowski T.	128, 151	Povenmire H.	54
Mignard F.	39	Prilutsky O. F.	69
Mikkola S.	96		
Milani A.	117, 151	Rabinowitz D. L.	166, 191
Millis R. L.	1, 160, 186,	Rahe J.	5
Minami S.	182	Ramsay D. A.	172, 174
Mitchell R.	6	Randall C. E.	29, 167
Miunonen K. O.	196	Ratcliff P. R.	148
Miyashita A.	229	Ratke L.	168
Mizutani H.	216	Rauer H.	48, 169
Moos H. W.	60	Redman R. O.	170
Moreels G.	41, 181	Reed K. L.	72
Morfill G.	76	Renard J. B.	133
Morley T.	190	Rendtel J.	171
Morrow E.	149	Rettig T.	91
Morton Y. T.	73	Rettig T. W.	172, 173
Moseley S. H.	139	Reuter D.	92
Mottola S.	50, 73, 152	Reuter D. C.	155, 175
Mueller B. E. A.	19, 153	Reynolds R. T.	238
Muinsonen K.	96, 154	Rickman H.	176
Mukai T.	124	Rietmeijer F. J. M.	177
Mukhin L. M.	69	Robertson M. C.	178
Mumma M.	51, 92, 155	Roessler K.	110, 179
Mumma M. J.	175, 246	Roettger E. E.	180
		Roper R. G.	73
Nakamura T.	156, 157, 229	Rotundi A.	15
Namiki N.	21	Rousselot P.	41, 181
Natour Gh.	254		
Nazarchuk B. K.	158	Saito M.	123
Neugebauer M.	235	Saito T.	123, 125, 182
Neukum G.	73, 152	Samarasinha N. H.	183
Neukum S.	50	Sandford S.	23
Nicholson P. D.	49	Satoh T.	184
Nishioka K.	123	Sauer M.	179
Nolan M.	159	Sauter L. M.	22
Nolan M. C.	33	Schlapfer M. F.	226
Numazawa S.	125	Schleicher D. G.	1, 160, 185, 186
		Schloerb F. P.	187
Obert P.	27	Schlosser W.	188
Obrubov Yu. V.	8	Scholl H.	70
Okamura S.	182	Schulz K.	83

Schulz R.	188	Taylor A. D.	9
Schwarz G.	130	Tedesco E. F.	218, 225
Schwehm G.	76, 189, 190	Tegler S.	234
Schwingenschuh K.	48	Tegler S. C.	35, 219
Scotti J. V.	191	Telesco C. M.	35
Sekanina Z.	192, 193, 194	ter Kuile C.	104
Shefer V. A.	195	Thiel K.	121
Shkodrov V.	51, 99	Tholen D. J.	220
Shkuratov Yu. G.	196	Thomas H.	168
Shock E. L.	197	Thrush J.	54
Shoemaker C. S.	93, 198	Todorovic-Juchniewicz B.	221
Shoemaker E. M.	93, 96, 135, 198, 199	Tokunaga A. T.	233
Shor V. A.	119, 200	Tozzi G. P.	61, 132
Shull J. M.	208	Tsuda T.	229
Shulman L. M.	201	Tsutsumi M.	229
Sichao W.	54		
Siddique N.	76	Urdahl R. S.	101
Sidorov V. V.	16		
Silverberg R. F.	139	Valsecchi G. B.	143
Šimek M.	202	Vancura O.	60
Sitarski G.	221	Van Flandern T. C.	222
Slaughter C. D.	131	Vanysek V.	25, 223
Slezak E.	20	Vaschkov'yak M. A.	224
Smither C. L.	203	Veeder G. J.	218, 225
Snow P.	206	Velichko F. P.	140
Sokolsky A. G.	204	Vernotte F.	41, 181
Solovaya N. A.	205	Vilas F.	150
Soma M.	54	Vladimirov S.	99
Song X.	101	Vollmer E.	254
Spinrad H.	31, 111		
Stamm J.	54	Walker R. G.	215, 226
Stathakis R.	172	Wallace B. J.	86
Steel D.	206, 207	Wang E.-K.	94, 227
Steel D. I.	9	Watanabe J.	88, 212, 228, 229, 230
Steiner G.	122	Weaver H. A.	231, 232, 233
Stern S. A.	26, 34, 208, 209	Webster A. R.	105
Štohl J.	165	Wehinger P.	91
Stooke P. J.	210	Wehinger P. A.	116, 234
Storrs A.	92	Weiguo G.	187
Storrs A. D.	211	Weissman P.	235
Strazzulla G.	12	Westphal J. A.	232
Suzuki B.	212	Wetherill G. W.	236
Svetashkova N. T.	213	Wettig R. W.	174
Swindle T. D.	214	Whipple F. L.	237
Sykes M. V.	215	Whitman P. G.	146
Szutowicz S.	215	Whitmire D. P.	146, 238
		Williams G.	54
Takagi Y.	216	Williams I. P.	67, 82, 244, 250
Takahashi T.	123	Williams J. G.	225, 239, 240
Takami H.	230	Wisniewski W. Z.	241
Takeuchi H.	182	Wolfe R. F.	135, 198, 242
Tancredi G.	217	Woszczyk A.	5

Wu C. Y. R.	243
Wu Z.	244
Wyckoff S.	5, 91, 116, 172, 173, 219, 234, 245
Xie X.	246
Xu X.-Y.	94
Xu Y.-L.	49
Yagudina E. I.	200
Yamamoto T.	124
Yeomans D. K.	247, 248
Yi Y.	29, 167
Yoshikawa M.	156, 157, 229, 250
Young J. W.	86, 249
Yuqiu W.	227
Zagretdinov R. V.	250
Zappalá V.	19, 35, 251
Zellner B. H.	252
Zerull R. H.	83
Zhou Q.	73
Ziolkowski K.	253
Zook H. A.	76, 100
Zscheeg H.	254